Leveraging Koopman Operators and Deep Neural Networks for Parameter Estimation and Future Prediction of Duffing Oscillators

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The study of nonlinear dynamical systems, has been a cornerstone in various scientific and engineering domains due to their widespread applicability in modeling real-world phenomena. Traditional methods for analyzing and predicting the behavior of such systems often involve complex mathematical techniques and numerical simulations. This paper introduces a novel approach that combines the power of Koopman operators and deep neural networks to generate a linear representation of the Duffing oscillator, enabling effective parameter estimation and accurate prediction of its future behavior. Furthermore, a modified loss function is proposed to enhance the training process of the deep neural network. The synergy of Koopman operators and deep neural networks not only simplifies the analysis of nonlinear systems but also offers a promising avenue for advancing predictive modeling in various fields.